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(54) **SYSTEM AND METHOD FOR ALLEVIATING FREEZING GAIT AND GAIT HYPOKINESIA IN USERS WITH EXTRAPYRAMIDAL DISORDER**

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A45B 3/04 (2006.01)

(52) **U.S. Cl.**
CPC .. ***A61H 3/04*** (2013.01); ***A45B 3/04*** (2013.01); *A61H 2201/0173* (2013.01); *A61H 2201/0188* (2013.01); *A61H 2201/5007* (2013.01); *A61H 2201/5058* (2013.01); *A61H 2201/5064* (2013.01); *A61H 2201/5071* (2013.01); *A61H 2201/5079* (2013.01)

(58) **Field of Classification Search**
CPC A45B 3/04; A61H 2201/0188; A61H 2201/5058
USPC 135/65, 66, 910; 362/102
See application file for complete search history.

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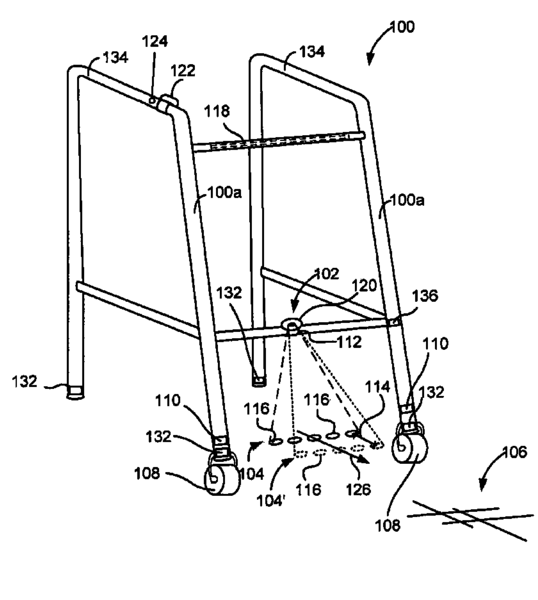
(57) **ABSTRACT**

An apparatus and a method for a walking aid are disclosed. The walking aid includes a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker. A swivel mount is supported by the frame. A light source is connected to the swivel mount. The light source is configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user. A controller is configured to adjust a visual property of the visual cue for use under indoor conditions and outdoor conditions.

17 Claims, 6 Drawing Sheets



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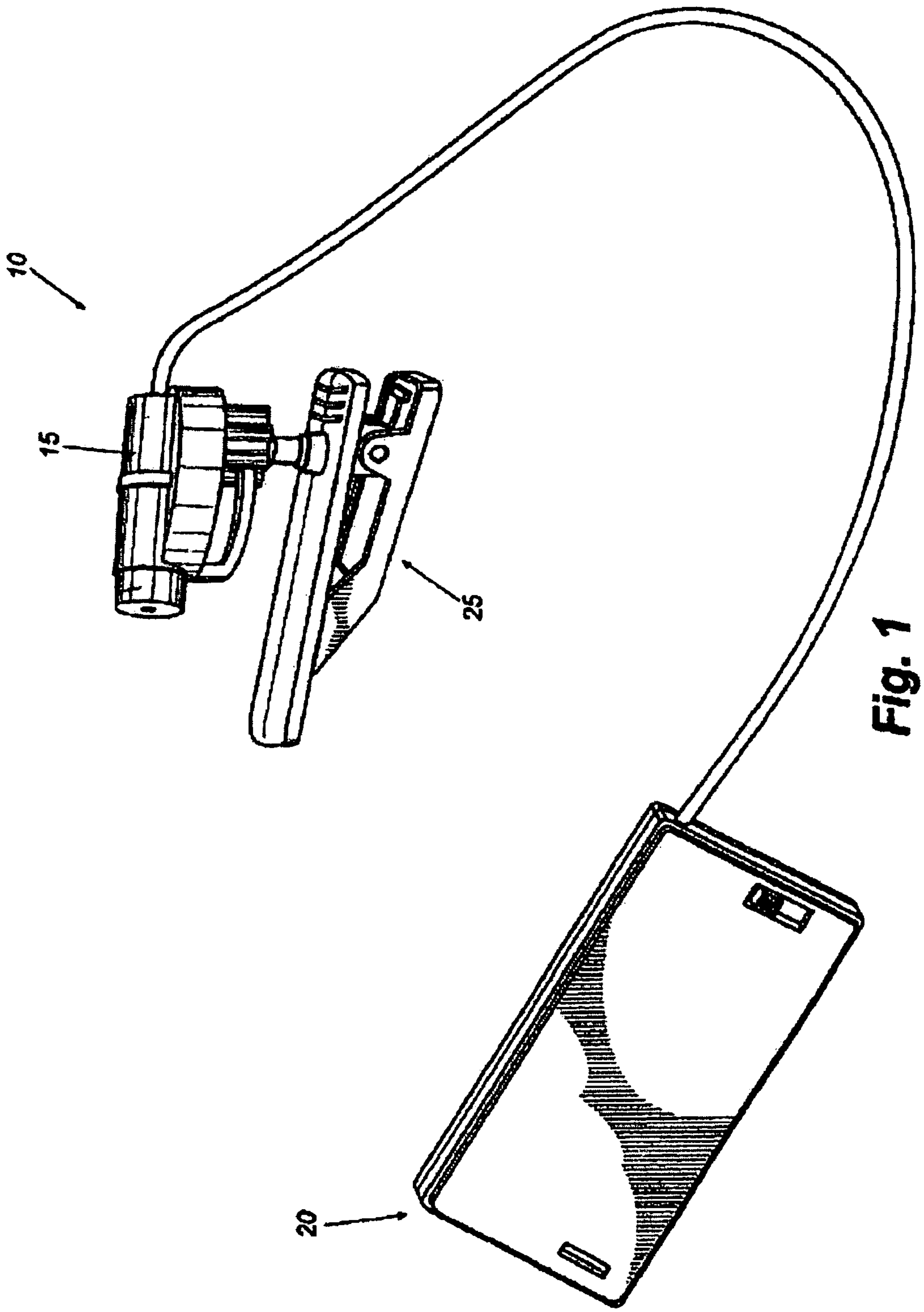

Fig. 1
-PRIOR ART-

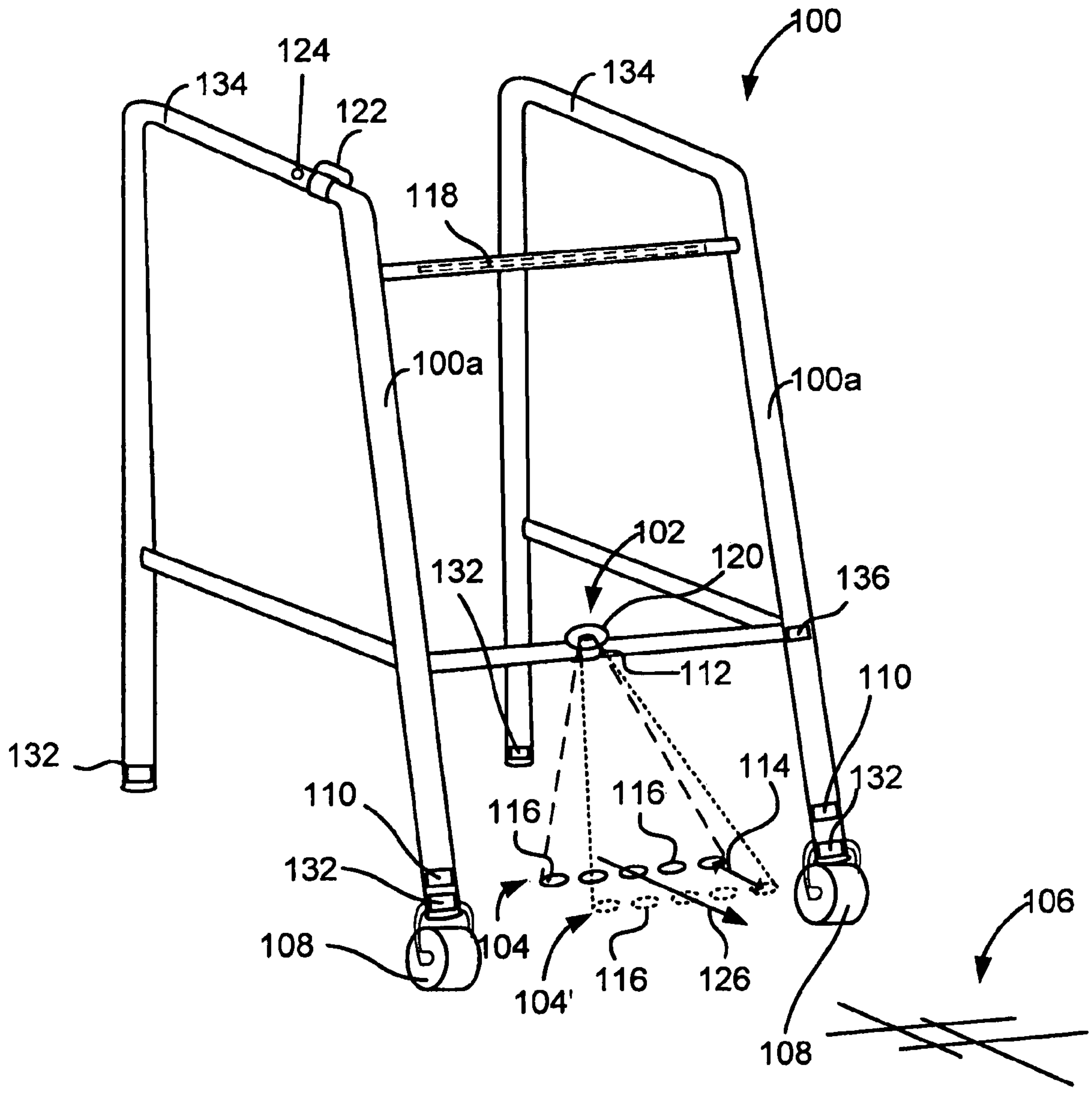
100
124
134
122
134
118
100a
100a
102
120
132
136
112
110
132
114
132
116
116
110
116
132
104
108
104'
116
126
106
108

FIG. 2

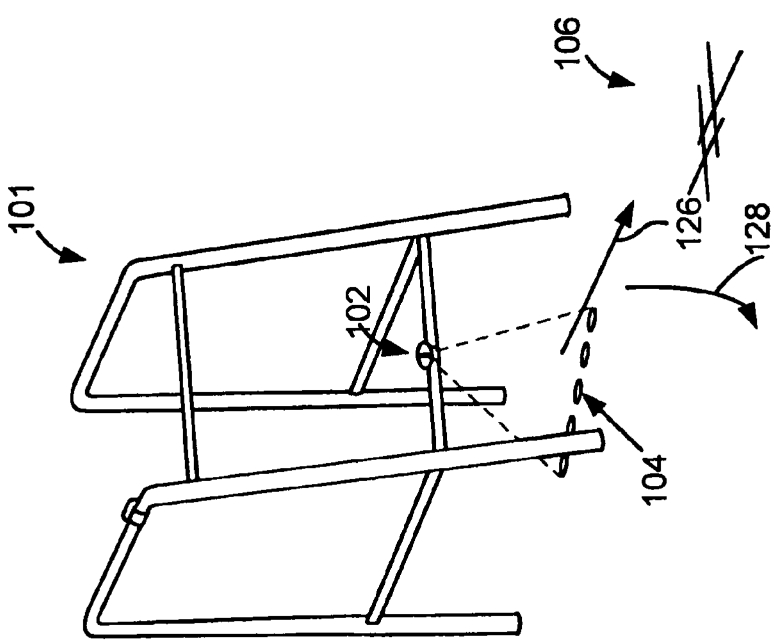

FIG. 3A

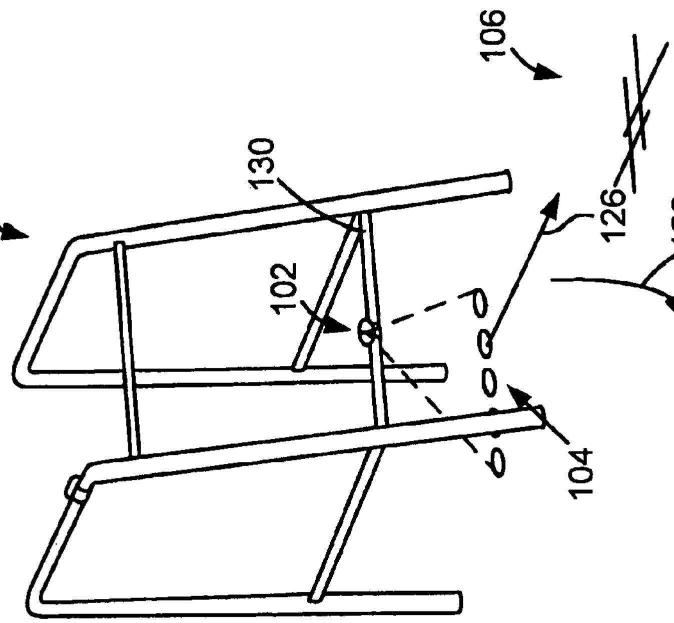

FIG. 3B

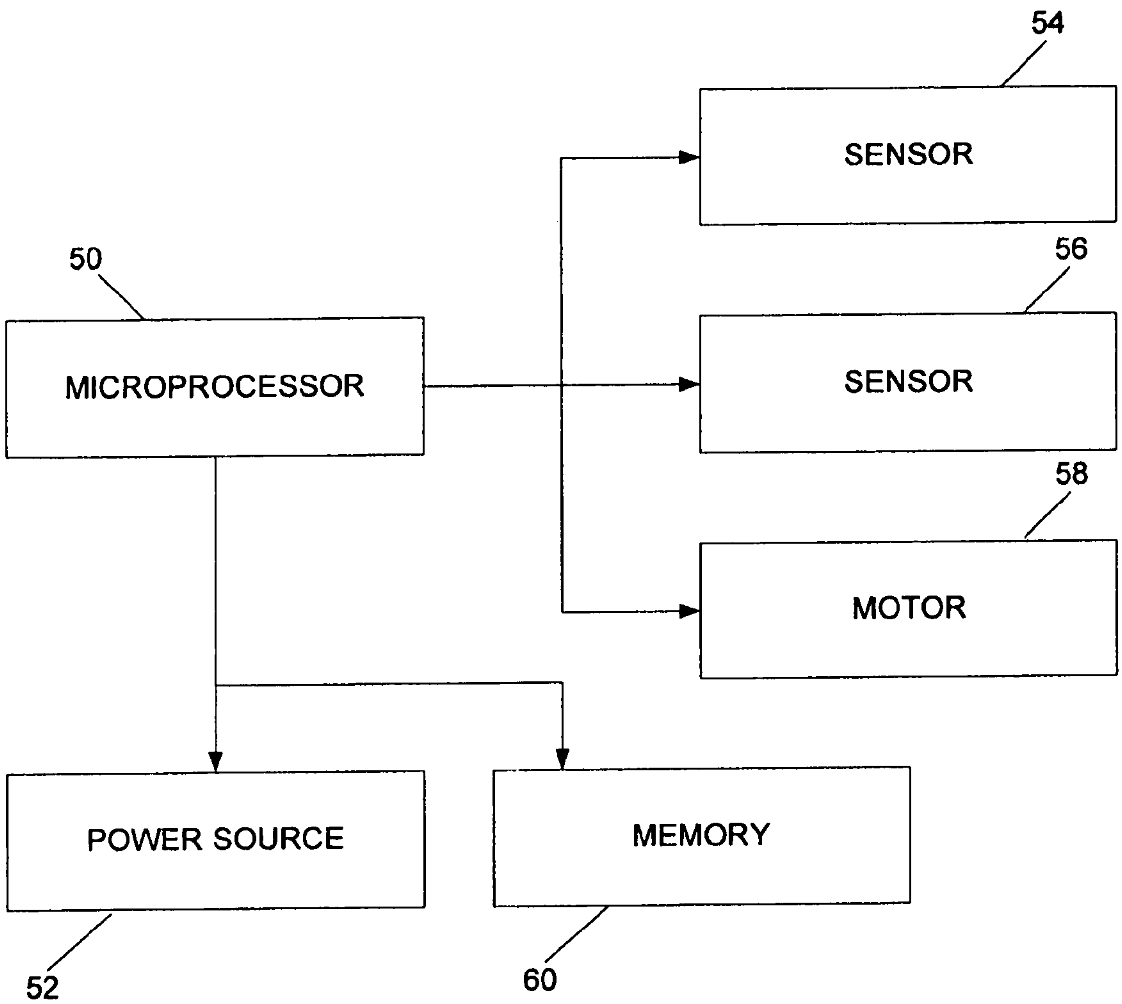
54
SENSOR
56
SENSOR
58
MOTOR
50
MICROPROCESSOR
POWER SOURCE
52
MEMORY
60

FIG. 4

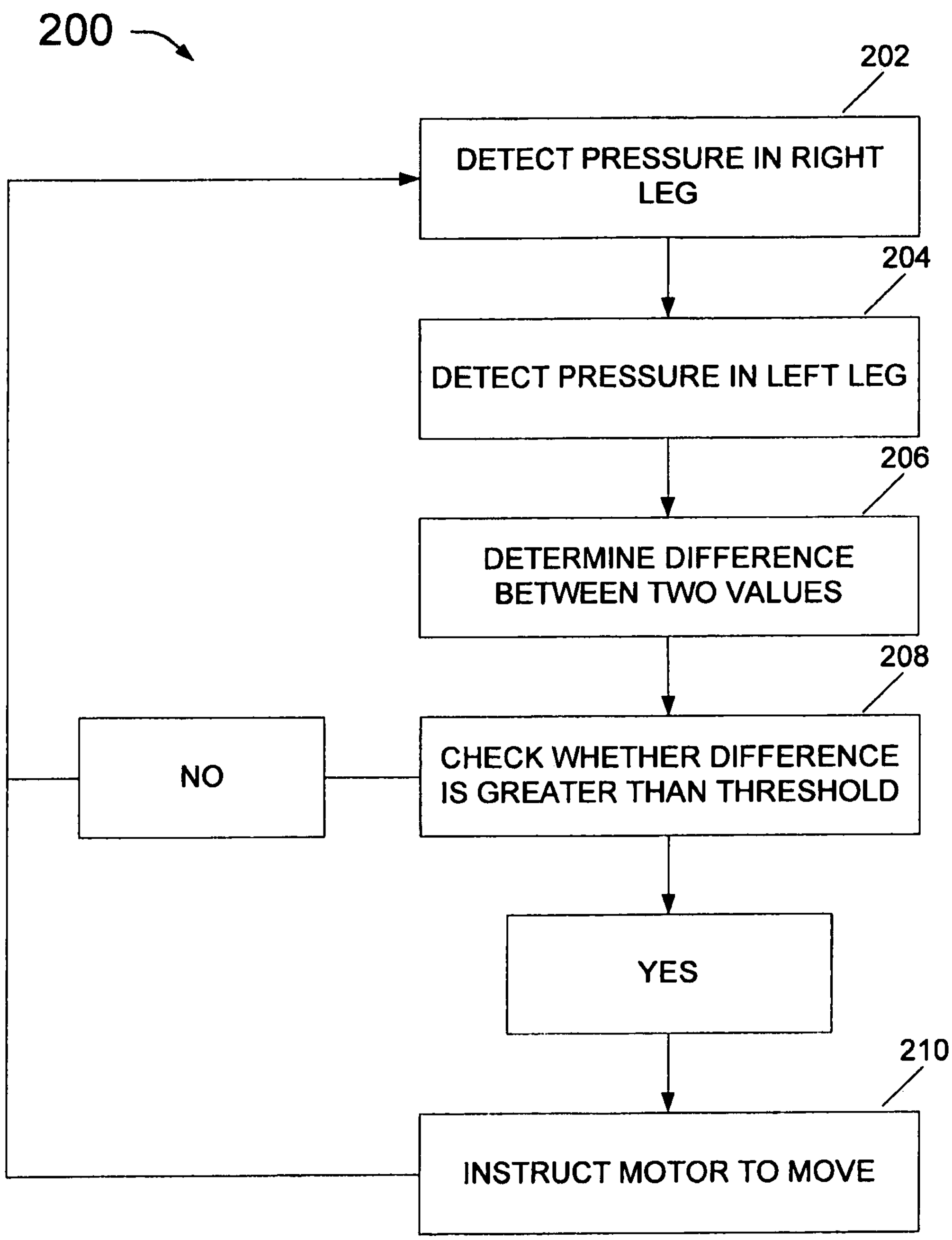
200
202
DETECT PRESSURE IN RIGHT LEG
204
DETECT PRESSURE IN LEFT LEG
206
DETERMINE DIFFERENCE BETWEEN TWO VALUES
208
NO
CHECK WHETHER DIFFERENCE IS GREATER THAN THRESHOLD
YES
210
INSTRUCT MOTOR TO MOVE

FIG. 5

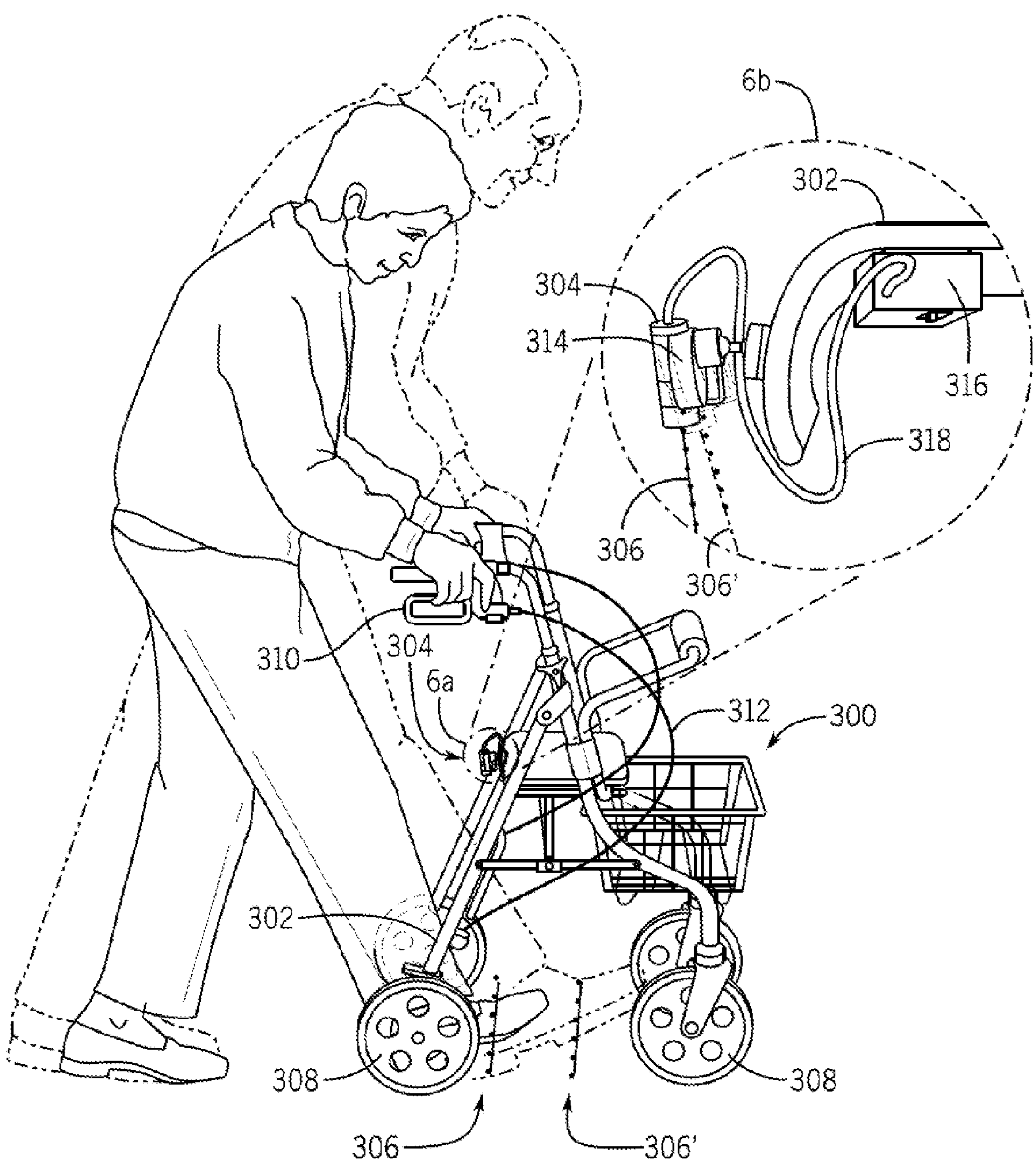
6b
302
304
314
316
318
306
306'
310
304
6a
312
300
302
308
308
306
306'

FIG. 6

SYSTEM AND METHOD FOR ALLEVIATING FREEZING GAIT AND GAIT HYPOKINESIA IN USERS WITH EXTRAPYRAMIDAL DISORDER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application represents the national stage entry of PCT International Application No. PCT/US2011/032051 filed Apr. 12, 2011, which claims the benefit of U.S. Provisional Patent Application Ser. No. 61/323,232, filed on Apr. 12, 2010, both of which are incorporated herein by reference in their entirety for all purposes.

FIELD OF THE INVENTION

The present invention generally relates to generating a visual cue for a user of a walker, or walking aid device. One aspect of the invention is to provide a constant or recurring stimulus to reduce or substantially eliminate the occurrence of "Freezing of Gait" (FOG), gait hypokinesia, or stride reduction in a user, such as one suffering from parkinsonism.

BACKGROUND OF THE INVENTION

Parkinsonism is a debilitating syndrome, encompassing several neurological diseases that compromise the motor skills of its victims. Such diseases include Parkinson's Disease, vascular Parkinsonism, Normal Pressure Hydrocephalus (NPH), multiple systems atrophy (MSA), progressive supranuclear palsy (PSP), and others. Globally, Parkinsonism and other such diseases are referred to as extrapyramidal disorders. As parkinsonism progresses, one particularly debilitating problem is "Freezing of Gait" (FOG), in which an individual locks up or becomes so fixated they are unable to move or initiate further stepping movements by their own volition. In some cases the individual feels "stuck to the floor" as if by a magnetic force. Unfortunately, FOG is not responsive to available medications. As a result, FOG poses a significant risk of injury to individuals if they are left unattended, even when trying to perform the most mundane tasks, and especially when they are in public settings, such as trying to cross a street. Accordingly, individuals suffering from FOG require constant monitoring and assistance.

A related problem which often occurs concomitantly in patients with FOG is gait hypokinesia. Gait hypokinesia entails patients taking with FOG is gait hypokinesia. Gait hypokinesia entails patients taking increasingly smaller steps. In a similar fashion to FOG, gait hypokinesia is often refractory to medications. A result can be that patients ambulate so slowly that they become discouraged and may increasingly opt to use a wheelchair or motorized scooter. However, by being able to walk, patients can prevent muscle atrophy, maintain cardiovascular health and bone density, and preserve a positive psychological outlook. Moderate exercise, or walking, has also been shown to correlate with a decreased likelihood of developing cognitive impairment such as Alzheimer's disease.

The incidence of Parkinson's disease is reported as 1% of the population over the age of 50, and 1.5% over the age of 65, with some occurrence in younger individuals but negligible incidence in children. Over half a million people in the United States are afflicted with this condition. Parkinsonism has an even broader impact with an occurrence of 30% over age 75 (where vascular Parkinsonism as the most common) and at ages over 85, more than 50% suffer some form of Parkinsonism.

People have attempted to manage these FOG episodes in various ways. The management techniques usually involve playing a "trick" on the brain. One technique that some use is to march or rock to sound cues such as marching music or counting. Another method is to provide some visual cue that encourages the feet to step up and over, as if unsticking from glue, rather than stepping forward, as with regular walking. These tricks are usually taught in the physician's office by the doctors, nurses, and therapists who are familiar with the symptoms. People also learn the methods from reading books about Parkinson's disease or by attending support group meetings. Because actual visual cues are often impractical outside of a controlled and prepared environment, such as a therapist's office, some are taught to draw an imaginary line in front of the afflicted person's feet and encourage him or her to "step up and over the imaginary line." Also used is the dropping or placing of objects on the floor in front of the person's feet; forcing them to step over the object (paper, tissue, straws, belts, and the like). Virtually any object can be used to "step up and over." A number of these methods are disclosed in U.S. Pat. Nos. 5,575,294; 6,330,888; US 2004/0144411; US 2006/0292533; and US 2007/0255186.

FIG. **1** is an illustration of an example prior art system **10** for projecting a visual cue to alleviate FOG in an individual such as that described in U.S. Patent Publication No. 2006/0025836, hereby incorporated by reference. The device includes a battery pack or power source **20** that is connected to light source **15**. Light source **15** is configured to project a visual shape or pattern. System **10** includes clip **25** for attaching light source **15** to a user or object. Generally, clip **25** is configured to attach to an article of the user's clothing, such as a belt, shoe, or waistband such that light source **15** directs the visual shape or pattern on the ground ahead of the user while the user walks.

Prior art projection systems such as that shown in FIG. **1** have several disadvantages. First, when attached to an article of the user's clothing, the position of light source changes as the user moves. Because the light source can shift around, at the time a user is affected by FOG, it is extremely unlikely that the light source will be correctly oriented to assist the user. Similarly, if the user is shaking or trembling, the light source will be affected by those movements, resulting in the visual pattern shaking violently over whatever surface the light source is oriented towards. Furthermore, because the pattern is projected some distance away from the light source, even the smallest movement of the user is magnified making the device extremely difficult to use.

Although the prior art systems may be attached to surfaces or objects that are relatively more stable, such as a cane, or walker, in order to provide a connection sufficient to fix the light source to the object safely, any such clip or attachment device must be extremely strong. Such a clip could be extremely difficult for an elderly person, or a person suffering from Parkinsonism or similar disease, to operate. As a result, conventional project systems such as that illustrated in FIG. **1** are of little benefit to a user suffering from FOG and gait hypokinesia. Furthermore, in many prior art devices the visual cue is directed an unhelpful position within the user's stride. Some devices, for example, generate a visual line that cannot be moved and projects onto a walking surface at approximately the level of a patient's heels.

The aforementioned systems have been helpful to people, but each has drawbacks. Sound cues (such as marching music) are not often feasible, particularly outside the home, and many find singing or counting aloud embarrassing. Dropping or placing items on the floor requires not only that you have the objects ready to use but that someone be available to place and retrieve the objects. One alternative to this is to use small disposable objects, such as cards, and leave the object(s) behind. With other objects, if the object is 3-dimensional, such as a belt, the individual could trip and fall. The imaginary line method works well, but again, someone usually must accompany the individual to draw the line with their foot or hand. Some patients find it difficult to imagine a line during the freezing episode and remain unable to move until involuntary release occurs.

The visual stimulations proposed also do not meet all of the needs of the user. The visual images are not adjustable in that they do not turn in the direction of the user's motion. Also, the challenges of different light conditions between indoors and outdoors are not addressed. Often, a Parkinsonian patient will just sit down and stop what he or she is doing. At the present time, these homemade tricks or clip-on devices are the only mechanical techniques available to individuals in the United States who suffer from freezing and gait hypokinesia. For many people, the above-listed techniques are too impractical to consider using consistently. Thus, there is a need for a system to assist sufferers of FOG, and gait hypokinesia that does not contain the above drawbacks.

SUMMARY OF THE INVENTION

The present invention is directed generally to a device and method for alleviating freezing of gait in a user, such as one suffering from parkinsonism or other extrapyramidal disorder. The device includes a light source, for example, a laser or LED, adjustably seated in a holder. The light source is focused into a visual cue. As the user steps toward the visual cue, the visual cue advances with the user, to create a continuing, successive stimulus for eliminating freezing for each step. If the user attempts to turn in a given direction, the device may actuate in such a way as to maintain the visual cue in front of the user.

In one implementation, the present invention includes a walking aid. The walking aid comprises a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker, a swivel mount supported by the frame, and a light source connected to the swivel mount. The light source is configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user. The walking aid further includes a controller configured to adjust a visual property of the visual cue for use under indoor conditions and outdoor conditions.

In other implementations, the present invention includes a walking aid. The walking aid comprises a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker, and a light source connected to the frame and configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user. The walking aid includes a processor connected to the frame and configured to determine an intended walking path of a user of the walker, the intended walking path deviating from the path, and position the visual cue in the intended walking path of the user.

In other implementations, the present invention includes a method of alleviating freezing of gait in a user of a walking aid. The method comprises detecting a differential weight input at a frame of the walking aid. The walking aid is configured to extend about a user to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walking aid. The method includes using the differential weight input to determine a projected path of the user, and projecting a visual cue in the intended walking path of the user using a light source configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user.

Other aspects and features of the present invention will become apparent in view of the figures and the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** depicts an example prior-art device comprising a light source connected to a clip for mounting the light source.

FIG. **2** is an illustration of the exemplary device of the present invention.

FIGS. **3**A and **3**B illustrate the exemplary device according to the present invention, after being angularly adjusted to match a user-initiated turn.

FIG. **4** is a diagram of the interrelated functional components of a walking aid that can be used to alleviate symptoms of, for example, FOG.

FIG. **5** is a flowchart illustrating a method for detecting that a user of the present system is initiating a turn.

FIG. **6** is an illustration of an alternative implementation of the present walking aid device.

DETAILED DESCRIPTION OF THE INVENTION

The present disclosure is directed to a device and method that may be used to alleviate "Freezing of Gait" (FOG) in a user suffering from parkinsonism or a similar neurological disorder. The device may also be used as a gait rehabilitation therapy to encourage a user suffering from gait hypokinesia that has decreased stride length to lengthen their stride. It has been known that some users of walkers may make sudden movements or leave their walker behind when rushing to make a turn. Therefore, the device may also be used to facilitate proper walker, or other walking aid, usage by encouraging the user to keep the walker properly situated in front of them in their direction of motion. Proper walker usage may also be improved with appropriate posture, which the present device can help to improve by encouraging a user to place their feet at an appropriate location beneath a walker. The device can also be used for fall prevention in that a user is encouraged to concentrate upon stepping in the appropriate places as directed by the light source, and therefore less likely to slip or inadvertently lose their footing.

The device and method of the present invention provide a visual cue to the user to cause or trigger an autonomic response. In one aspect, the visual clue is a line or other pattern projected onto a projection surface (e.g., a ground surface) orthogonal to the direction of motion of the user, typically on the floor or ground. The line may also be turned such that it is no longer lateral to the sides of the walker or walking aid, but is instead orthogonal to the newly intended direction of motion upon entering a turn. It has been found that such a line can trigger a response in parkinsonism sufferers to step on or across the visual cue, thereby eliminating the freezing for at least that step. Successive visual cues can be created as the user moves forward. The device and method of the present invention, therefore, use a visual cue to alleviate FOG. Although various examples of the present system and method are described in the present disclosure as alleviating FOG in an individual, it is to be understand that the present system may be generally used to alleviate FOG in addition to stride reduction or gait hypokinesia in an individual. As such, in the following discussion, references to FOG should be understood to apply equally to stride reduction and gait hypokinesia.

With this visual cue, fall prevention may also be facilitated by leaning forward to step on or over the visual cue. The user may be less prone to falls from auto-retropulsion a result of impaired postural reflexes which commonly affect patients with Parkinsonism.

FIG. **2** depicts an embodiment of the present walker **100**. Light source **102** is configured to project visual cue **104**. Visual cue **104** is configured to spread out on the floor, ground surface, or another projection surface **106**, ahead of or behind the front feet or wheels of walker **100** having front legs **100***a* and in the walking path of the user (indicated by arrow **126**). Visual cue **104** may include a single solid projection, or several separate projections, such as projections **116** shown in FIG. **2**. Although a single, solid projection may facilitate viewing, for battery saving purposes, a broken, or dashed visual cue **104** can be used.

Visual cue **104** is configured to move either forward or backward (e.g., from position **104** to position **104'**) by a distance **114** in such a way as to accommodate the preference of the walker's user, or to facilitate a particular treatment. That is, for fall prevention, for example, visual cue **104** can be positioned to be directed over a user's feet such that the user concentrates on where their feet have been or will be located. With gait training for example, the visual cue can be projected out ahead of the user to provide the user with a goal to lengthen the user's stride in order to reach the visual cue.

In some cases, walker **100** includes a controller (e.g., implemented by microprocessor **50** of FIG. **4**) that automatically accommodates the user's stride length by monitoring a movement of walker **100** to characterize the stride length of the user. Then, based upon the determined stride length, the controller can select an appropriate position for the visual cue **104**, for example by moving the visual cue from position **104** to position **104'** as shown in FIG. **2**, or to accommodate any other stride length appropriate for the user.

In one implementation, walker **100** includes a system such as an inertial measurement unit or system, or global position system (GPS) connected to the controller to detect movement (including both velocity and distance) of walker **100**. Alternatively, in walkers that include wheels **108** (such as walker **100** illustrated in FIG. **2**), walker **100** movement is detected using one or more wheel sensor **110** connected to either, or both, wheels **108**. After collecting some movement data from walker **100** using any of the above measurement systems (either individually or in combination), the controller can than analyze the movement data to identify distances over which walker **100** is characterized by constant movement, followed by pauses, indicating that the user has taken a step. This information can be used to determine the stride length of the user, which can then be used to identify an appropriate positioning of visual cue **104** to achieve the optimum performance of walker **100**, either by assisting the user in controlling stride length, or to direct visual cue **104** over the user's feet to assist in fall prevention, for example. After determining the stride length of the user, the controller moves visual cue **104** by an appropriate distance **114** to position visual cue **104** in the optimum location.

A bracket and clamp arrangement may secure light source **102** to walker **100**. In the implementation shown in FIG. **2**, light source **102** is coupled to walker **100** using universal swivel mount **112** that connects the light source to a mounting bracket allowing the light source to pivot. Swivel mount **112** may include a universal joint, such as a cardan joint, hardy-spicer joint, or hooke's joint. Alternatively, swivel **112** may include a ball and socket joint to allow for free movement of light source **102**. As described below, a motor or other actuator may be coupled to swivel **112** for adjusting a position and orientation of light source **102**.

The light source may be powered by any suitable energy source, for example, one or more batteries. Any size battery may be used as needed to supply sufficient power to the light source. Additionally, the battery or batteries may be rechargeable. Rechargeable batteries also may be used to stabilize voltage or current of the power source. If desired, a pressure sensitive ceramic, an electromechanical generating device, or a similar medium may be used to produce the necessary power for the light source. The power source may be enclosed in a housing or pack which may include a band, clip, or other fastener to secure the housing to a belt, walker, coat pocket, or the like.

In one implementation, energy source **118** is mounted within the frame of walker **100** and connected to light source **102**. With the energy source mounted within the walker, the user of walker **100** is not required to carry a power source separately. As shown in FIG. **2**, in one implementation, energy source **118** is mounted within a cross bar of walker **100**. This configuration ensures a lateral weight balance between the left side and the right side of walker **100**. By maintaining an evenly-balanced weight distribution, there is less danger that walker **100** will tip, particular when lifted by a user. In other implementations, however, the energy source may be mounted within walker **100** at any suitable location, even if to one side of walker **100**, for example by being disposed within one leg of walker, or outside of the walker.

The light source may be a laser source (e.g., a type 3A, 635 nanometer laser (Laserex Model LDM-4-635-3-L30) emitting a red light configured in a line at three milliwatts, with the line being projected at a distance of 90 centimeters (cm) from the line's origin, with the line having a length of approximately 60 cm), such as a YAG or helium-neon laser, capable of high intensity, or a Krypton bulb source. The optical element(s) of the system may consist of any suitable combination of prisms, gratings, grisms, or collimators (see, for example optical element **120**) that creates the desired pattern from the laser beam. Or the optical elements may be limited to a simple cast or molded shaped glass or plastic article having a shape that internally reflects light and serves as a beam-shaping waveguide body that spreads the round beam into a strip-like curtain and projects it as a collimated rectangular beam, so that no further optical elements are required for focus or shape adjustment. Another possibility is for an individual LED or group of LEDs to be used. However other optics, different patterns or pattern-defining elements, and other light sources may be used as well.

Light source **102** may also include a color which is easily discernable in both outdoor and indoor conditions or changeable for various lighting conditions. For example, in some circumstances, a green laser (e.g., having a wavelength of approximately 495-570 nanometers) shows up much more readily in outdoor day light, but can be overly bright for indoor conditions where a red laser (e.g., having a wavelength of approximately 620-750 nanometers) can be more efficacious. The light source can therefore be modifiable to contain a dual red/green laser system where the user can specify which they would like to use, or the device can automatically select which is appropriate based upon light conditions using a controller such as processor **50** (for automatic selection) or a manual switch such as switch **122** shown on FIG. **2**). This same concept can be extended to LED or other light sources. In some implementations, the walker includes a light sensor (see, for example, sensor **136** of FIG. **2**) to detect a level of ambient light. Based upon the light level (and, in fact, the spectrum of ambient light), the walker may be configured to select the most appropriate output light color for the light source. If, for example, the light sensor detects a high level of ambient light, a more intense, bright output color may be output by the light source at a higher power level. Conversely, in low ambient light conditions, the walker may select a different, more appropriate, color and output the light using less power.

A separate switch button **122** is positioned for ease of activation to turn the light source on and off. This switch may include a heat activated switch, a pressure activated switch, a timer switch, or some other form of tactile switch. Light emitting diode (LED) **124** may be provided to indicate whether the device is powered on. In one aspect, a pulsed LED is used to conserve power and increase battery life. Switch **122** can be a push button switch, and a set of rechargeable batteries from within the device provides the power supply. A timer connected to, for example, switch **122** of FIG. **2** may be configured so that, once the switch is pressed, the unit stays lit for a fixed short time interval, for example, two, five or ten seconds. Alternatively, the device may be provided with a motion or other sensor (not shown) that automatically turns the device off after a period of inactivity. Likewise, the device may be provided with a sensor that automatically turns the device on when motion is detected, for example using wheel sensors **110**. In some such aspects, the sensor further may be adapted to detect motion in a desired direction or at a minimum height, such as detecting a forward motion or movement of the user using wheel sensors **110**, so that motion caused by shaking of the user would not necessarily activate the device. A control may be included that blinks the power on and off during the actuation period. This may be useful either for charging a high power storage device to fire a strobe light (e.g., xenon flash source) to obtain higher intensity, in which case the unit serves to adapt a low voltage power source to a high intensity light source, or the source may blink simply to make the projected light pattern **104** more visually noticeable to enhance its effectiveness for overcoming a freezing incident.

Numerous mounting positions for light source **102** are possible on the body of the walker **100**, and different forms of articulation or brackets may provide flexibility in aiming the device. Depending on the form of illumination employed, light source **102** may be mounted as shown in FIG. **2** on a front cross member, at a position low to the ground, to maximize the intensity of the projected image, or higher up on a side bracket or cross-piece or on a seat mounted to the walker. In embodiments where the projector is built into a leg or in a cross bar, it may have internal wiring to button **122** to allow a user to control the operation of light source **102**. Alternatively button **122** may function wirelessly in order to be located at a more easily reached position for activating the projection controls for light source **102**. Whether light source **102** is integral or added on, the frame of the walker **100** generally provides a fixed reference that allows light source **102** to be precisely and, in some cases, permanently aimed and focused on a ground surface in the correct position. In a walker with roller wheels, the activator button can be mounted adjacent to one of the hand brake control levers.

FIGS. **3**A and **3**B show alternative implementations of the device, wherein walker **101** is configured to direct visual cue **104** to different positions on a projection surface **106** (e.g., the ground) to assist a user in making a turn with walker **101**. By adjusting the position of visual cue **104** on the ground or projection surface, the device can prompt a user to take a step where the stepping foot does not move along the user's previous walking path and, instead, is placed to one side of the walking path. For example, by moving visual cue **104** away from the walking path, a user can be prompted to take a step where the foot is place to one side of the walking path, thereby initiating a turn. By maintaining visual cue **104** in a displaced position, after taking a number of steps, the user can complete the desired turn.

FIG. **3**A depicts the light source **102** and visual cue **104** as the user initiates a right-hand turn (from the user's perspective) away from walking path **126** towards the turned walking path **128**. As the user initiates a turn, light source **102** and visual cue **104** are rotated by rotation of light source **102** (e.g., by movement of universal bracket **112** of FIG. **1**) through a predetermined arc in such a way as to aid the user in maintaining concentration on the visual cue. In one such embodiment, visual cue **104** may be represented by a line (or broken line) which is kept fixed at its right end as a pivot point, and the rest of the line is rotated clockwise around the right end. The pivot point could be changed; for example it could be in the middle of visual cue **104** or visual cue **104** could be rotated in some other fashion and this example is not intended to be limiting in any way. If the cue had remained stationary, the user may not have maintained concentration on the visual cue, or may not have received a benefit from the cue at all, and would therefore have suffered from FOG or another of the detriments that the device is designed to treat.

FIG. **3**B depicts another embodiment of how the visual cue **104** could be moved while the user initiates a right-hand turn. In this embodiment, the visual cue is not rotated but is offset or translated in such a way as to move the cue to the right (in the direction of the turn **128**) and away from the user's original path **126** (though it could also be moved towards the user if so desired). In the example shown in FIG. **3**B, the translation can be achieved by a mechanism that moves light source **102** back and forth along the cross bar **130** of walker **101**.

In both of the above embodiments depicted in FIGS. **3**A and **3**B, the universal swivel (see, for example, element **112** of FIG. **2**) is actuated in such a way as to move the light source in order to rotate or move visual cue **104** into a displaced position along the new direction of travel when a user makes a turn. This can be accomplished in a number of possible ways. One way is for gyroscopes to be attached either to the device or the walker which will indicate when the direction of travel is changing, and will control the swivel either directly or through a computer processing means to move the visual cue. Another possibility is for pressure sensors to be mounted in the feet, legs, or handles of the walker such that when a person leans on one side of the walker thereby placing more pressure on one side of the walker's legs indicating the user is making a turn, the swivel will move the visual cue accordingly. Depending upon the implementation, the sensors may be placed in each leg of the walker, or in only two of the legs. Generally, any sensor system that allows for the determination of whether the user is pressing down more heavily on one side of the walker or the other can be used in conjunction with the present system. For example, sensors may be placed in the handles of the walker to detect a weight or pressure applied to the handles or the legs of the walker. In that case, although not measuring a weight or pressure applied to the legs directly, the handle sensors measure such a force indirectly.

With reference to FIG. **2**, for example, pressure sensors **132** are disposed within each leg of walker **100**. As shown in FIG. **2**, pressure sensors **132** may be disposed proximate the feet, or wheels of the various legs of walker **100** to allow for accurate readings to be taken at each point walker **100** contacts ground surface **106**. Alternatively, weight or pressure sensors may be mounted within handles **134** of walker **100** to detect a weight applied by the hands of the user.

FIG. **4** is a block diagram illustrating the functional components of a walker configured to automatically adjust a position of the swivel to move the light source to facilitate the turning of a user. Microprocessor **50** is mounted on or within the walker and connected to power source **52** and memory **60**. Microprocessor **50** is also in communication with sensors **54** and **56**. In one implementation, sensor **54** is configured to detect a weight or pressure applied to a left side of the walker (e.g., through a handle or leg of the walker), while sensor **56** is configured to detect a weight or pressure applied to the right side of the walker. In other implementations, though, different combinations of sensors may be used for detecting a weight or pressure applied to any number of legs or handles of the walker.

Microprocessor **50** executes software that retrieves data from sensors. Using the data from sensors **54** and **56**, microprocessor **50** determines whether a user is applying more weight to either the right or left side of the walker, or whether the walker is in balance. As such, microprocessor **50** can be configured to detect a differential weight input to the handles of the walker. If microprocessor **50** detects more weight to one side than another, the processor determines that the user is initiating a turn and instructs motor **58** to modify a position of the light source (e.g., light source **102** of FIGS. **2**, **3**A, and **3**B) to assist in such a turn. The degree to which the light source is displaced can be at least partially determined by the degree of difference in pressure applied to one side of the walker versus the other.

FIG. **5** illustrates a method for directing the visual cue of the present system using pressure sensors mounted within a walker. Although method **200** is described in terms of a walker having two pressure sensors (see, for example, the block diagram of FIG. **4**), with one configured to detect a weight applied to a left leg and one configured to detect a weight applied to a right leg, method **200** may be modified to work with walkers having other combinations of sensors.

Method **200** may be executed by a microprocessor mounted to or within a walker. In a first step **202**, the microprocessor retrieves a measurement from a first sensor configured to detect a weight or pressure applied to one of the right legs of the walker. In step **204**, the microprocessor retrieves a measurement from a second sensor configured to detect a weight or pressure applied to one of the left legs of the walker.

The processor then determines the difference between the two values in step **206**. If the difference is greater than a predetermined threshold in step **208**, then in step **210**, the processor instructs a motor connected to the swivel mount to move the lighting device to a corresponding, predetermined position. The differences may have positive values, indicating the user is turning in a first direction, or negative values, indicating the user is turning in a second direction. Depending upon system requirements, many different thresholds can be defined, where thresholds having larger absolute values indicates sharper turns causing a greater displacement of the light source. After turning the light source, method **200** repeats. In some cases, extreme thresholds may be defined that indicate the weight differential is so great that the walker is in danger of tipping. In that case, if the weight differential exceeds the threshold, the walker may be configured to sound an alarm via a speaker connected to the frame of the walker to alert the user as to the possible tipping condition.

If the difference between the two sensor values does not exceed a predetermined threshold, then method **200** returns to step **202** and repeats.

After completing a turn, the user stops applying a differential pressure to the walker and both the right leg and left leg sensor detect the same pressure (or the same pressure within a predetermined error margin). In that case, the microprocessor causes the motor to return the light source to its non-displaced position. In some cases, therefore, if the answer to step **208** of FIG. **5** is no, the processor always causes the light source to return to its default position.

In some implementations, the sensor system includes memory **60** (shown on FIG. **4**) for storing several sensor measurements made over a period of time such as the last 5 or 10 seconds. For example, the system may store sensor measurements every 1 second and store a maximum of 10 records. By recording several sensor measurements, the processor can compare the most current measurement to those made over some time to identify trends or anomalies. This may be used to alleviate problematic measurements resulting from a user of the walker momentarily striking or pushing down on one handle of the walker. Accordingly, the memory can be used to smooth out measurements. In one specific implementation, during the comparison step **208** shown in FIG. **5**, before comparison, the processor may average the last 10 measurements for the left leg and the right leg sensor so that the processor compares only average measurement values, not the most recent values.

In some cases a user will naturally apply a different weight to the handles of the walker during use, even when walking in a straight line. As such, that user's normal operation, even when moving in a straight line, results in an unbalanced input at the walker's handles and, consequentially, the walker's legs. In that case, the walker may be configured to allow a user to establish a default position. The default would allow the user to define the unbalanced input as that user's normal, straight line input. Deviations from that input, then, could be used to identify when the user is initiating a turn and to determine appropriate positioning of the light source. The default may be stored in memory and used by the processor to compensate for a user's walking technique.

Yet another possibility is for the device to track where the user is looking, and move the visual cue according to where they are looking to move. If the user looks to the right, the visual cue will move or rotate to the right. If the user looks to the left, the visual cue will move or rotate to the left.

FIG. **6** is an illustration of an alternative implementation of the present walking aid. Walking aid **300** includes frame **302** configured to extend at least partially about a user and provide support to that user as he or she progresses along a walking path.

Light source **304** is connected to frame **302** of walker **300**. Light source **304** is configured to project visual cue **306** into the walking path of the user, or over the feet of the user, as discussed above. As shown in FIG. **6**, a position of visual cue **304** can be adjusted (e.g., from the position of visual cue **306** to the position of visual cue **306'**) to assist the user. The position may be selected to alleviate FOG, to assist in modifying the stride length of, or to mitigate gait hypokinesia in the user, again, as described above. As illustrated in FIG. **6**, the position of visual cue **306** may be, at least in some part, determined by a height of the user of the walker **300**.

Walker **300** includes a number of wheels **308** to facilitate movement of walker **300**. Wheels **308** may be connected to wheel sensors, as described above, for monitoring a movement (e.g., speed and distance) of the walker for determining an appropriate position of visual cue **306** for the user. Wheels **308** are connected to braking levers **310** for controlling the rotation of wheels **308**. Braking levers **310** are connected to the brakes of wheels **308** via cables **312**.

Referring to FIG. **6**, box **6***b* shows an enlarged portion of the region indicated by box **6***a* on FIG. **6**. As shown in box **6***b*, light source **304** is connected to frame **302** of walker **300** via bracket **314**. Bracket **314** may be configured in the same manner as universal swivel mount **112** of FIG. **2**, for example. Alternatively, bracket **314** can include any light source **304** mounting system that can be adjusted to control a position of visual cue **306** on a project surface for a user. Also, as discussed above, bracket **314** (or light source **304**) may be connected to a motor or other actuator for automatically modifying a position or orientation of light source **304** via a controller, such as a user interface (e.g., a switch or button) or via commands issued by a controller.

Light source **304** is connected to power or energy source **316** via cable **318**. Energy source **316** may include a control switch that is configured to control power delivery to light source **304**, or to otherwise control an operation of light source **304**, for example by causing light source **304** to periodically flash, change color, modify a position of light source **304**, or otherwise control an operation of light source **304**. In that case, power source **314** may incorporate, or be in communication with a processor or controller (such as microprocessor **50** of FIG. **4**) for determining an appropriate position of visual cue **306** and controlling at least one of a position and orientation of light source **304** to position visual cue **306** in, or proximate to, that determined location.

In the same manner as the prior art, the device could be used in conjunction with a belt, a hat, a shoe, a cane, or the like, or placed somewhere else on a user or a walking aid. Accordingly, it will be readily understood by those persons skilled in the art that, in view of the above detailed description of the invention, the present invention is susceptible of broad utility and application. Many adaptations of the present invention other than those herein described, as well as many variations, modifications, and equivalent arrangements will be apparent from or reasonably suggested by the present invention and the above detailed description thereof, without departing from the substance or scope of the present invention.

The invention claimed is:

1. A walking aid, comprising:

a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker;

a swivel mount supported by the frame;

a light source connected to the swivel mount, the light source configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user;

a controller configured to adjust a visual property of the visual cue for use under indoor conditions and outdoor conditions;

further comprising a motor connected to at least one of the swivel mount and the light source to modify at least one of a position and an orientation of the light source to modify a position of the visual cue on the projection surface with respect to the path;

further comprising a first sensor connected to the walker to detect a first pressure applied to the walker; and

wherein, in response to the first pressure detected by the first sensor, the motor is configured to adjust the at least one of a position and an orientation of the light source to project the visual cue away from the path and toward a projected path.

2. The walking aid of claim **1**, wherein the controller is configured to receive an indication of the first weight detected by the first sensor and, using the indication of the first pressure, determine the projected path implied by the first pressure and communicate the adjustment of the at least one of a position and an orientation of the light source to the motor to project the visual cue away from the path and toward the projected path.

3. The walking aid of claim **1**, wherein the swivel mount is configured to automatically adjust a position of the visual cue in response to directional changes by the user and the walking aid includes at least one of a gyroscope, pressure sensor, and user eye tracking system configured to monitor directional changes by the user.

4. The walking aid of claim **1**, further comprising a collimator disposed around the light source and configured to increase an intensity of the light source on a predetermined projection area.

5. The walking aid of claim **1**, wherein the light source is configured to generate first and second visual cues.

6. The walking aid of claim **5**, further comprising a light sensor connected to the frame and configured to detect an ambient light level about the walker, and wherein the controller is configured to use the ambient light level to select one of the first visual cue and the second visual cue for outputting by the light source.

7. The walking aid of claim **5**, wherein the first visual cue is configured for indoor use and the second visual cue is configured for outdoor use.

8. The walking aid of claim **7**, wherein the first visual cue consists of a light having a wavelength between approximately 620 nanometers and approximately 750 nanometers and the second visual cue consists of a light having a wavelength between approximately 495 nanometers and approximately 570 nanometers.

9. A walking aid, comprising:

a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker;

a swivel mount supported by the frame;

a light source connected to the swivel mount, the light source configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user;

a controller configured to adjust a visual property of the visual cue for use under indoor conditions and outdoor conditions;

further comprising a motor connected to at least one of the swivel mount and the light source to modify at least one of a position and an orientation of the light source to modify a position of the visual cue on the projection surface with respect to the path;

further comprising a first sensor connected to the walker to detect a first pressure applied to the walker;

further comprising a second sensor connected to the walker at a position displaced from the first sensor to detect a second pressure applied to the walker at the position displaced from the first sensor;

wherein the controller is configured to receive an indication of the first pressure detected by the first sensor and an indication of the second pressure detected by the second sensor and determine a differential therebetween and, using the differential, determine a projected path implied by the differential and communicate an adjustment of the at least one of a position and an orientation of the light source to the motor to project the visual cue away from the path and toward the projected path.

10. The walking aid of claim **9**, wherein the controller is configured to:
compare the differential to a predetermined threshold; and when the differential exceeds the predetermined threshold, communicate the adjustment of the at least one of a position and an orientation of the light source to the motor.

11. A walking aid, comprising:
a walker having a frame configured to extend about a user of the walker to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walker;
a light source connected to the frame and configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user; and
a processor connected to the frame and configured to:
determine an intended deviation from the path of the user of the walker, and
position the visual cue in the intended deviation from the path of the user of the walker by altering the position of the light source with respect to the frame of the walker.

12. The walking aid of claim **11**, wherein determining the intended deviation from the path of the user includes:
receiving an indication of a pressure differential applied to the frame of the walker;
using the indication of the pressure differential to determine a projected path implied by the differential; and
adjusting a position of the visual cue to position the visual cue away from the path and toward the projected path.

13. The walking aid of claim **11**, wherein the light source is configured to generate first and second visual cues.

14. The walking aid of claim **13**, further comprising a light sensor connected to the frame and configured to detect an ambient light level about the walker, and wherein the processor is configured to use the ambient light level to select one of the first visual cue and the second visual cue for outputting by the light source.

15. A method of alleviating freezing of gait in a user of a walking aid, comprising:
detecting a differential pressure input at a frame of the walking aid, the walking aid configured to extend about a user to at least partially support the user and to facilitate the user progressing along a path from a current step to a next step while at least partially supported by the walking aid, the walking aid including a light source configured to project a visual cue on a projection surface in the path between the current step and the next step to trigger the next step by the user;
using the differential pressure input to determine a projected path of the user; and
projecting a visual cue in the projected path of the user by altering the position of the light source with respect to the frame of the walking aid.

16. The method of claim **15**, wherein the light source is configured to generate first and second visual cues.

17. The method of claim **16**, further comprising:
detecting an ambient light level about the walking aid; and
using the ambient light level to select one of the first visual cue and the second visual cue for outputting by the light source.

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